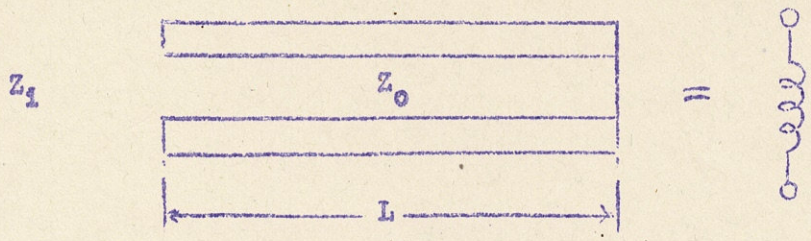
HIGH FREQUENCY DESIGN NOTES

1.0 IMPEDANCE OF A SHORT CIRCUITED LINE



for lengths shorter than $\frac{\lambda}{4}$

$$Z_1 = +j\, Z_o \text{ TAN } BL \quad \text{----------(1)}$$

Example 1. A line has a Z_o of 100 Ω and a length (L) of 22 inches. What is the input impedance at 100 mc. What size condenser would it take to resonate the line.

Solution $L\left(\frac{\lambda}{4}\right)$ at 100 mc $\cong$ 30 INCHES

$$BL = \frac{L}{L\left(\frac{\lambda}{4}\right)}\ 90^\circ = \frac{(22)(90)}{30} = 66^\circ$$

$$Z_1 = +j\ 100 \text{ TAN } 66^\circ = j(100)(2.25)$$

$$Z_1 = \underline{+j225 \text{ OHMS}}$$

$$X_c = Z_1 = -j225 \text{ OHMS}$$

$$C \cong 6 \text{ uuf}$$

Example 2. Design a line section to resonate with a 7 uuf condenser at 150 mc.

Solution

Condenser Reactance X_c (7 uuf) = -j 150 OHMS

Line Impedance Z_1 = +j 150 OHMS

Assume Z_o = 100 ohms

Find BL, the electrical length of the line.

$$\text{Tan } BL = \frac{Z_1}{Z_o} = \frac{150}{100} = 1.5$$

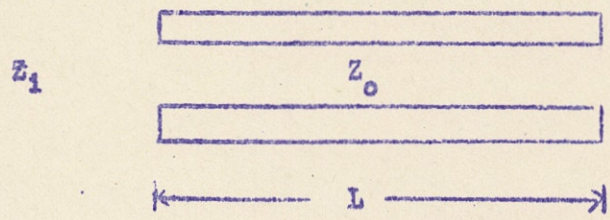
$$BL = 56.3^\circ$$

$$L\ \left(\frac{\lambda}{4} \text{ at 150 mc}\right) \cong 20"$$

$$L = \left(\frac{BL}{90^\circ}\right)\ 20" = \left(\frac{56.3}{90}\right)\ 20 = \underline{12.5 \text{ INCHES}}$$

Line required would have a Z_o of 100 ohms and a length of 12.5 inches.

2.0 IMPEDANCE OF AN OPEN CIRCUITED LINE

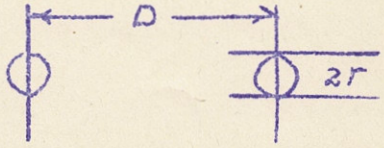


$= \perp$ for lengths shorter than $\frac{\lambda}{4}$

$$Z_1 = -jZ_o \cot BL \quad \text{----------(2)}$$

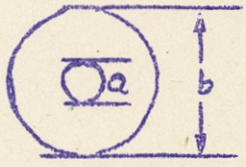
3.0 CHARACTERISTIC IMPEDANCE OF A TWO WIRE LINE

$$Z_o = 276 \log \frac{D}{r} \quad \text{----------(3)}$$



4.0 CHARACTERISTIC IMPEDANCE OF A CONCENTRIC LINE

$$Z_o = 138 \log \frac{b}{a} \quad \text{----------(4)}$$



5.0 CAPACITY OF TWO PLATE AIR CONDENSER

$$C \cong \frac{A}{4d} \quad \text{micro micro farads ----------(5)}$$

A = Area of one plate - square inches

d = Spacing - inches

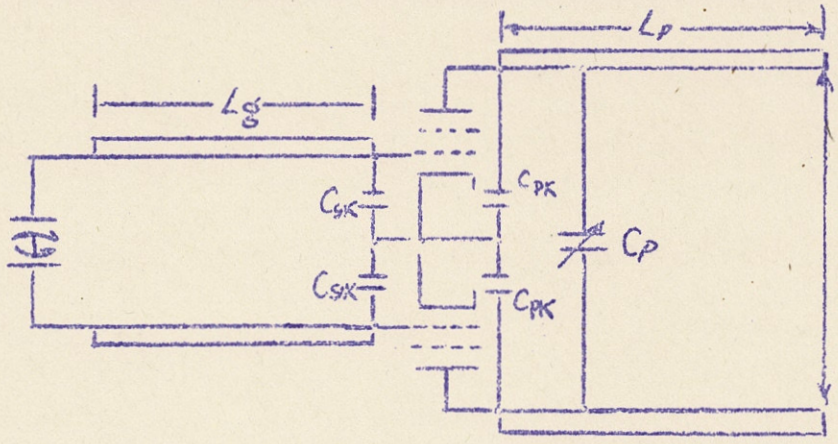
6.0 REACTANCE OF A CONDENSER

$$X_c = -j\frac{160{,}000}{fc} \text{ OHMS} \quad \text{-----------(6)}$$

f = frequency in mc

c = capacity in uufd

7.0 CALCULATION OF PLATE AND GRID LINES FOR 815 TUBE



C_{pk} = 8 uuf

C_{gk} = 14 uuf

PLATE LINE COMPUTATION

1. Assume frequency = 150 mc.
2. λ = 2 meters $L\left(\frac{\lambda}{4}\right)$ = 20 INCHES
3. Assume space considerations limit plate line to 10" length.
4. Make line spacing ratio $\frac{D}{r}$ = 4
5. Assume Conductor radius = .25" then D, the spacing, = 1"
6. $Z_o = 276 \log \frac{D}{r} = 276 \log 4 =$ <u>165 OHMS</u>
7. The problem is now to find the inductive impedance (Z_1) looking into a line 10" long with a Z_o of 165 ohms.
8. From equation (1) above

   $Z_1 = +j Z_o \text{ TAN } BL$

   $BL = \frac{L}{L\left(\frac{\lambda}{4}\right)} 90^\circ = \left(\frac{10"}{20"}\right)\left(90^\circ\right) = 45^\circ$

   $Z_1 = +j\ 165 \text{ Tan } 45^\circ = +j(165)(1.00)$

   $Z_1 = +j\ 165 \text{ OHMS}$

9. The capacitative reactance (X_c) required to resonate this line is then -j 165 ohms or C = 5.5 uuf.

10. Since $C_{\frac{pk}{2}}$ = 4 uuf C_p = 1.5 uuf

11. Summarizing:

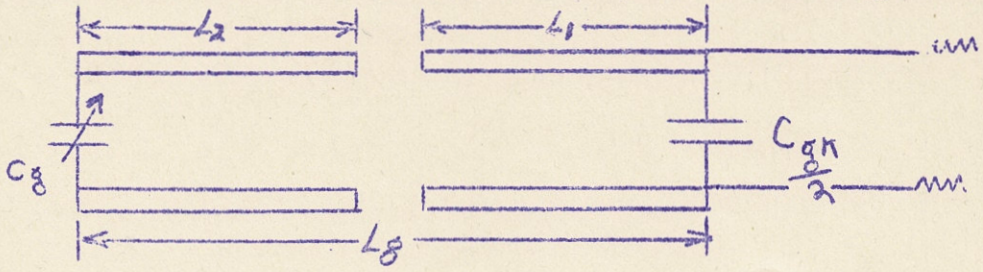
L_p = 10" LONG - Two 0.5" diam. rods spaced 1".

C_p = 1.5 uuf.

GRID LINE COMPUTATIONS

1. Assume it is desired to use a half wave line tuned at the far end.

2. First determine the amount of line required to resonate the grid cathode capacity and then compute the additional line and tuning condenser necessary to be equivalent to a quarter wave length.



3. $C_{\frac{gk}{2}} = \frac{14}{2} = 7$ uuf.

4. $X_c = -j\ 150\ \Omega$

5. Assume $Z_o = 165\ \Omega$

6. Find electrical length BL_1 and physical length L_1.

7. TAN $BL_1 = \frac{X_c}{Z_o} = \frac{150}{165} = 0.91$

$BL_1 = 42^\circ$

$L_1 = \left(\frac{42^\circ}{90^\circ}\right)(20") = 9.35"$

8. A line of this length neglects the inductance of the grid leads so and estimate must be made. Assume grid inductance is equivalent to about 3" of line. Then the net line length $L_1 \cong$ 6 INCHES.

9. Assume 12" is the maximum space available. The L_2 will have to be 12" minus 6" = 6 inches.

10. The problem is now to find the value of the condenser at the far end of the line, C_g which will resonate with 6 inches of line having a Z_o of 165 ohms.

11. Z_i (line L_2) $= +j\, Z_o \tan BL_2$

$BL_2 = \left(\frac{6"}{20"}\right)\left(90^\circ\right) = 27^\circ$

$Z_i = +j\ 165 \tan 27^\circ = +j(165)(.51)$

$Z_i = +j\ 82.5$ OHMS

12. $X_{C_g} = -j\ 82.5$

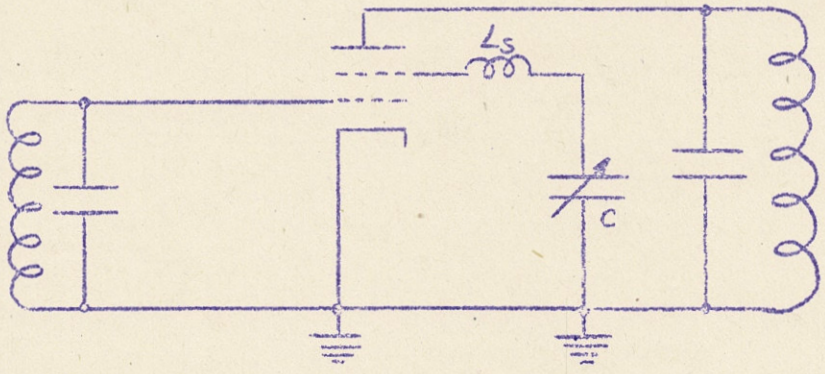
$C_g \cong 12.5$ uuf

13. Summarizing

1. Grid line = 12" long Z_o = 165 ohms
2. C_g = 12.5 uuf

8.0 NEUTRALIZING CIRCUITS

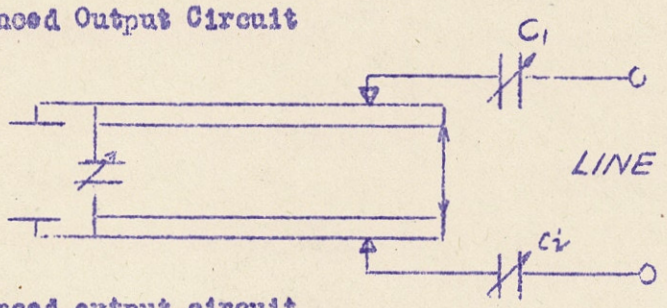
Screen Neutralization of Tetrodes



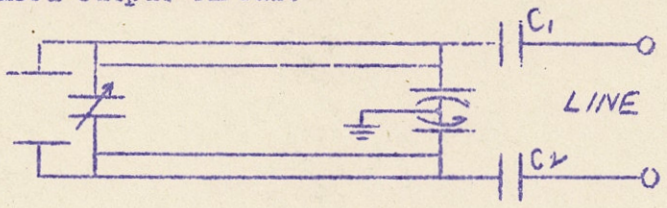
Inductance of screen leads L_s is resonated by variable condenser C to form a series resonant or zero impedance circuit to ground. This puts the screen at ground potential and effectively isolates the input and output circuits.

9.0 ANTENNA COUPLING CIRCUITS

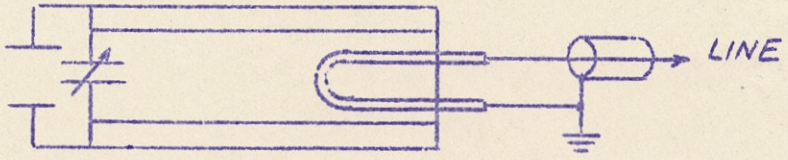
1. Balanced Output Circuit



2. Balanced output circuit



3. Unbalanced Output circuit



4. Unbalanced Output circuit